Saskatchewan
Environment

Hydrology Branch

Frenchman River Basin Hydrology Study

November, 1983
HYD-2-8

This report has been prepared primarily for internal use by Saskatchewan Government agencies. Material should not be used without approval.

FRENCHMAN RIVER BASIN

HYDROLOGY STUDY

REPORT NO. HYD-2-8

Prepared by:

H. E. Mahood, P. Eng.
Investigations Division
Hydrology Branch

November, 1983

TABLE OF CONTENTS

	Page
TABLE OF CONTENTS	i
LIST OF TABLES	ii
LIST OF FIGURES	iii
SYNOPSIS	iv
Chapter	
I INTRODUCTION	1
A. GENERAL	1
B. THE BASIN	1
C. BASIN DEVELOPMENT	2
D. APPROACH TO THE STUDY	6
II BASIN STUDY DATA	8
A. HYDROMETRIC RECORDS AND OTHER DATA	8
1. Tributary Flow	8
2. Main Channel Flow and Other Data	9
B. BASIN DIVISIONS	13
1. Cypress Lake Sub Basin	13
2. Divisions along Main Stem Frenchman River	14
III RUNOFF POTENTIAL AND WATER USE	18
A. DRAINAGE AREAS	18
1. Cypress Lake Sub Basin	18
2. Frenchman River Main Stem	19

TABLE OF CONTENTS (continued)

Chapter		Page
B.	NATURAL RUNOFF VOLUMES	20
	1. Natural Flow Computations	20
	2. Cypress Lake and Basin Segment No. 1	22
	3. Basin segments No. 2 and No. 3	25
	4. Basin Segment No. 4	27
	5. Basin Segment No. 5	28
C.	WATER DIVERSION AND USE	30
IV	RESULTS OF THE STUDY	40
A.	CONCLUSIONS	40
	1. Hydrometric Records	40
	2. Water Supply and Present Use	42
B.	RECOMMENDATIONS	43
	1. Hydrometric Program	43
	2. Further Study	44

LIST OF TABLES

Table No.		Page
1.	HYDROMETRIC RECORDS FOR THE FRENCHMAN RIVER BASIN STUDY	11
2.	RIVER REACHES AND REACH DIVISIONS ALONG THE FRENCHMAN RIVER MAIN CHANNEL	17
3.	CYPRESS LAKE NATURAL DRAINAGE AREAS	19

LIST OF TABLES (continued)

Table No.		Page
4.	NATURAL DRAINAGE AREAS FOR REACHES ALONG FRENCHMAN RIVER MAIN STEM	21
5(a)	ANNUAL MEDIAN NATURAL RUNOFF AND PRESENT DIVERSION FOR FRENCHMAN RIVER BASIN AREAS (METRIC UNITS)	35
5(b)	ANNUAL MEDIAN NATURAL RUNOFF AND PRESENT DIVERSION FOR FRENCHMAN RIVER BASIN AREAS (ENGLISH UNITS)	36

LIST OF FIGURES

Figure No.

1 FRENCHMAN RIVER BASIN SHOWING DRAINAGE BOUNDARIES, DIVISIONS AND HYDROMETRIC STATIONS

SYNOPSIS

The Frenchman River in Saskatchewan has a long narrow basin extending from its western extremity in the south slopes of the Cypress Hills to beyond where the river crosses the International Boundary, some 18 townships to the east. With its dry or semi-arid climate water availability has always been of concern to residents, since the area was first settled in the late 1800s.

Being an international stream, the Frenchman River comes under apportionment, and 50 per cent of the natural river flow at the boundary must be passed to the United States. Median runoff into Cypress Lake under natural conditions would not normally contribute to river flow, and is therefore not considered shareable under the apportionment agreement.

By 1939 three storage reservoirs were developed in conjunction with the respective Eastend, West Val Marie and Val Marie irrigation projects, and dams at both ends of Cypress Lake were constructed to increase the available storage there. Works were also installed for diversion of runoff into Cypress Lake, and for release from that storage into either the Frenchman River or Battle Creek.

In the present study the basin was considered according to its component parts, that is, Cypress Lake sub basin and five river reaches or basin segments along the main river channel. Past and present water use was evaluated and median natural runoff estimated for each local area.

It was found that the available median runoff is sufficient, after providing for present use in both minor and major projects, to allow some further project development in every local area considered. The lowest proportion of available water presently being used, was in Basin Segment No. 5, the most downstream local area of the basin.

Chapter I

INTRODUCTION

A. GENERAL

In November, 1974, a decision was made by the Water Rights Branch, Saskatchewan Environment, to restrict further irrigation development in the Frenchman River Basin in Saskatchewan. This decision was based on a 1973 water supply study which concluded that the basin was overallocated on a median annual runoff basis. Recent public pressure by some individuals for irrigation development prompted the Water Rights Branch to reassess the 1973 study. As a result of this reassessment and in light of increased project operation and water use information it was decided that a new hydrology study should be undertaken.

In a memo dated January 20, 1982, the Water Rights Branch requested the Hydrology Branch to undertake a comprehensive hydrology study of the Frenchman River Basin in Saskatchewan. This report describes the methodology, data analysis and results of this study.

B. THE BASIN

The Frenchman River Basin is a long narrow basin which extends from its western extremity in Township 7, Range, 28, W3 in the Cypress Hills, southeastward to the International Boundary, where the river crosses in Range 10. The northern boundary of the basin follows a portion of the continental divide,

separating northward drainage from that leading south into the Missouri River system. Most of the basin runoff originates from drainage of the south slopes of the Cypress Hills, and similarly farther east, from a continuing summit and ridge of hills, which forms part of this continental drainage divide. A map of the Frenchman River basin is shown on Figure 1.

The upper or western end of the basin is tributary to Cypress Lake which, under natural conditions, would overflow only occasionally to the Frenchman River; in higher runoff years. To the east of Cypress Lake, the river valley meanders through four townships to Eastend and receives runoff from a large area lying to the north in the Cypress Hills. Downstream from Eastend the river runs southeasterly and away from the main body of the Hills. To the east of Highway No. 37 and extending along the river to its crossing of the International Boundary, there is drainage from a considerable depth of area in hills lying to the north and east of the main channel.

After crossing the International Boundary the Frenchman River runs southward for a distance in Montana before joining the east flowing Milk River, which in turn discharges into the Missouri River.

C. BASIN DEVELOPMENT

Like much of southwest Saskatchewan the Frenchman River basin has a dry or semi-arid climate, and in fact the annual

precipitation averages only about one-third of the annual evaporation. Meeting annual water requirements has always been of concern to ranchers and other residents since the area was settled in the late 1800s. In this respect the drought years of the 1930s were particularly difficult. By 1939 three reservoirs, Eastend, West Val Marie and Val Marie, had been developed along the main stem Frenchman River, and dams had been built at the east and west ends of Cypress Lake.

The construction of a dam at each end of Cypress Lake reduced the surface area of the lake, but the storage capacity was greatly increased by raising the full supply level on the modified lake or reservoir. Constructed along with each dam were associated works, through which additional water can be diverted into Cypress Lake from Battle Creek on the west and adjacent creeks on the east, and releases from storage can be made either to Battle Creek or to the Frenchman River.

Diversion of Frenchman River tributaries into Cypress Lake, starting in 1939, is through two diversion structures and associated canals. Runoff from upper Davis Creek is diverted into a canal which discharges into Belanger Creek, and downstream on the latter creek there is another diversion into the Cypress Lake East Inflow Canal. Neither of these diversions is total, hence, the proportion of streamflow bypassing the diversion and continuing down the respective

creeks varies from year to year. Sucker Creek, which formerly discharged directly into Cypress Lake, is now intercepted and discharges into the modified lake through the same East Inflow Canal. Releases from Cypress Lake storage into the Frenchman River are carried through the Cypress Lake East Outflow Canal.

At the west end of Cypress Lake, Oxarat Creek flow, which formerly discharged directly into the lake, is now taken across the Cypress Lake West Inflow Canal in a flume to irrigate areas in the flat to the south. In higher runoff years excess water in Oxarat Creek would probably find its way further south into the Cypress Lake West Outflow Canal and therefore, into Battle Creek. Oxarat Creek therefore, does not at present contribute to Cypress Lake.

Cypress Lake reservoir has a large live storage capacity in the order of 98 700 dam^3 (80,000 acre-feet) at full supply level. However with a relatively large surface area, evaporation tends to be high and median annual inflow under natural conditions would be only a fraction of the total live storage capacity.

Eastend reservoir is located on the Frenchman River main stem, immediately upstream from the Town of Eastend. It is a relatively small reservoir used mainly for diversion to the Eastend irrigation project. Water can be diverted into the

irrigation canal or released downstream along the river channel. The Town of Eastend, for example, diverts water out of the main channel downstream of the reservoir. West Val Marie and Val Marie reservoirs[1]/ are located some distance upstream from the Village of Val Marie. Storage capacities at full supply level for Eastend, West Val Marie and Val Marie reservoirs are, respectively 2470, 4320 and 11540 dam^3. Like at Eastend each of the Val Marie reservoirs is used to supply water to a major irrigation project in the immediate area.

Throughout the basin there are smaller individually licensed projects which divert and use water. These range from small domestic and stockwatering dams to spring flood and summer diversion irrigation projects of varying size. Many of these projects date back to the early years of settlement and ranching in the area. Taken together these "minor" diversions constitute a significant part of total water use in the basin, and must be included in any current evaluation of the available water supply.

1/ These two water bodies are presently named "Huff Lake" and "Newton Lake" respectively. However in this report for convenience and clarity, as well as to keep the more functional "storage" aspects in mind, they will be referred to by the respective older names, West Val Marie and Val Marie reservoirs, as indicated above.

Runoff from the Frenchman River in Saskatchewan is shareable under a treaty administered by the International Joint Commission. Under the rules of apportionment Canada has an obligation to pass 50% of the natural flow in the main river channel at the International Boundary to the United States and meeting this obligation is a necessary part of water administration in the Saskatchewan portion of the basin. Constructing additional reservoirs has been considered as a means of making more efficient use of the available water, and for controlling flow to meet downstream requirements.

D. APPROACH TO THE STUDY

Past studies carried out in the Frenchman River basin, have emphasized international apportionment, that is on the volume of flow which, under natural conditions, would cross the International Boundary and is therefore shareable under treaty with the United States. Such studies do not necessarily provide definitive answers to questions faced by water administrators concerning the availability of water in a particular area, and whether or not they should authorize further project development in one area in relation to other areas within the basin.

For the present study the objective was to concentrate more on estimating the available water supply in each local area or segment of the basin and whether or not such runoff, under

natural conditions, would flow across the International Boundary.

In addition to estimates of runoff, past and present, water use in the basin is an important aspect of the study. Water Rights Branch, as part of their contribution to the study made a comprehensive tabulation of water development projects in the basin. Included in the summary, in addition to file number and name of applicant, is land location and purpose of diversion, status of licence, capacity of works, estimated annual diversion and estimated date on which the diversion began. In addition the tabulation indicates whether or not the project is within the effective drainage area, that is, within the area which would contribute to main stem flow in a median runoff year.

Chapter II

BASIN STUDY DATA

A. HYDROMETRIC RECORDS AND OTHER DATA

1. Tributary Flow

Flow measurement in the basin dates from the early years of this century, when a major and commendable effort was made to establish hydrometric stations to monitor tributary and main channel flow. However many stations were operated for only a few years, and in the present perspective the length and consistency of record for tributary flow especially, leaves much to be desired.

In the years from 1909 to 1912 hydrometric stations were established in each of the six main Cypress Hills tributary creeks - Oxarat, Sucker, Belanger, Davis, Fairwell and Conglomerate. Two of these stations were operated only until 1919, three until 1928 and the remaining station was discontinued in 1931. For a short period 1939 through 1945 the stations on Sucker and Belanger Creeks were reactivated, and an additional station operated in Belanger Creek immediately below the recently installed diversion.

Starting in 1939 hydrometric stations have been operated in the Cypress Lake East Inflow Canal below the diversion from Belanger Creek, and in the Cypress Lake East Outflow

Canal. This monitoring of diversions into, and releases out of, Cypress Lake was needed for purposes of international apportionment of flow. There are no records of flow diverted from upper Davis into Belanger Creek, and apart from the short six year period on Sucker and Belanger Creeks already mentioned, there appears to have been no monitoring of tributary flow since 1939 in the entire upper basin above Eastend.

In that part of the basin downstream from Eastend hydrometric stations were operated during a short three year period, 1914-16 inclusive, at locations in such tributary creeks as Bate Creek northwest of Val Marie, Breed and Little Breed Creeks downstream of Val Marie near the International Boundary. In 1914 a station, 11AC025, was also established on Denniel Creek near Val Marie. Although this is a currently active station it was not operated in the years 1932-34 and 1938-62. Even with the many missing years, this is the only substantially long station record of tributary flow in the entire basin area downstream from Eastend.

2. Main Channel Flow and Other Data

On the main stem Frenchman River, flow measurement also started in the earlier years before 1920. Some of the early, as well as the later established stations were

operated for a relatively few years, while others were operated for a longer period. Two of the stations started in the early period, however, are still in operation. Long-term records for Frenchman River below the present Eastend reservoir, with only a few missing years, extend back to 1909, and continuous records of flow at the International Boundary are available starting in 1917. Other main stem stations with shorter, but still significant, periods of record include Frenchman River above Eastend reservoir, below Eastend irrigtion project, at 50-Mile, below Val Marie reservoir and below Val Marie. Of this latter group the only currently active station is at Frenchman River below Val Marie reservoir.

Consistent records are available for reservoir levels, and for flows diverted from storage into the Eastend canal and irrigation canals at each of West Val Marie and Val Marie reservoirs.

The location and period of record for hydrometric stations useful or significant for the present study are shown in Table 1. Many station locations are also indicated in the basin map on Figure 1. It may be noted from the tabulation that the earliest stations set up and operating consistently were located in the upper part of

Table 1

HYDROMETRIC RECORDS FOR FRENCHMAN RIVER BASIN STUDY

Station Number	Station Name	Location (W3 in Canada)	Period of Record (in 1900s)
(A) Stations on Main Channel			
11AC001	Frenchman River below Eastend Reservoir	SE 36-6-22	09-16, 18-31, 35, 36, 39-82
11AC018	Frenchman River above Eastend Reservoir	NW 23-6-23	12-17, 37-66
11AC067	Frenchman River at Highway No. 37	NE 30-4-18	63-69
11AC057	Frenchman River below Eastend Irrigation Project	SW 26-5-20	37-55, 62-75
11AC023	Frenchman River at 50-Mile	SW 30-5-15	14-31, 35-55, 64-69
11AC062	Frenchman River below Val Marie Reservoir	NE 15-4-14	39, 65-82
11AC051	Frenchman River below Val Marie	NE 9-3-13	37-75
11AC027	Frenchman River at Buzzard's Ranch	NW 3-2-11	14, 15
11AC041	Frenchman River at International Boundary	SE 5-1-10	17-82
11AC040	Frenchman River at Drury's Ranch	SE 28-6-25	18-28
(B) Stations on Tributaries to Cypress Lake			
11AC009	Oxarat Creek at Wylie's Ranch	SE 29-6-27	09-19
11AC008	Sucker Creek at Gilchrist's Ranch	SW 25-6-26	09-28, 39-45
(C) Stations on Tributaries to Main Channel			
11AC016	Belanger Creek above Cypress Lake East Inflow Canal	SW 30-6-25	12-28, 39-45
11AC059	Belanger Creek below Cypress Lake East Inflow Canal	SW 30-6-25	39-45
11AC004	Davis Creek at Drury's Ranch	NE 29-6-25	09-28
11AC003	Fairwell Creek at Drury's Ranch	NW 30-6-24	09-31
11AC002	Conglomerate Creek at Cross Ranch	NE 16-7-22	08-19
11AC024	Bate Creek at Bate's Ranch	SW 7-6-16	14-16
11AC025	Denniel Creek near Val Marie	SW 21-4-13	14-31, 35-37, 63-82
11AC026	Breed Creek near Buzzard's Ranch	NW 3-2-11	14-16
11AC028	Little Breed Creek near Buzzard's Ranch	NW 11-2-11	14-16
(D) Stations on Canals and Diversions			
11AC072	Cypress Lake East Inflow Canal	NE 24-6-26	39-45
11AC064	Belanger Creek Diversion to Cypress Lake	NW 19-6-25	46-82
11AC060	Cypress Lake East Outflow Canal	SE 19-6-26	40-82
11AC052	Eastend Canal	NW 25-6-22	37-82
11AC065	Huff Lake Gravity Canal	SW 7-5-14	46-82
11AB077	Cypress West Outflow Canal	SW 16-6-27	40-82
11AB078	Cypress West Inflow Canal	SE 18-6-27	40-82
(E) Stations on Adjacent Basins			
05JA003	McDonald Creek near McCord	SW 1-6-7 (In USA)	65-67, 69-82
11AE007	McEachern Creek at International Boundary	SW 1-37-36-2PM	24-76

the basin, such as station 11AC001 at Eastend in 1909, and other tributary creeks upstream of that location. Downstream from Eastend flows were not recorded in Denniel Creek until 1914, and at the International Boundary until 1917. In the adjacent basin of McEachern Creek records date back only to 1924. In the present study this situation has significance for the beginning of the period in different parts of the basin for which natural flows can be reliably estimated.

Other data on Frenchman River runoff is available from sources which have used hydrometric records in the computation of natural flow. For example, in annual reports to the IJC[1]/ on the Division of Waters of St. Mary and Milk Rivers there is a historical summary which includes the computed value of natural runoff at the International Boundary for each year since 1940.

Natural flows at a number of potential water storage sites in the basin were estimated for the 1912-74 period by PFRA Hydrology Division as part of a study[2]/ in 1976. Of the nine locations studied only two were on tributary

---

1/ International Joint Commission.

2/ See Hydrology Report No. 84, "Water Supply Studies," which is Appendix A to the overall report "Engineering Study of Water Storage Potential in Frenchman River Basin," PFRA Engineering Service, October, 1976.

creeks. However, of some interest or application for the present study were the flows estimated for Cypress Lake, Fairwell Creek and the Frenchman River at Eastend and at the International Boundary.

B. BASIN DIVISIONS

1. Cypress Lake Sub Basin

As already mentioned the drainage pattern around Cypress Lake has been changed quite significantly by the construction of dams, canals and other water control structures. There are portions of the natural drainage area which no longer contribute runoff to the modified lake, namely the Oxarat Creek tributary area, which may contribute to Battle Creek through the West Outflow Canal, a small part of Sucker Creek downstream from its confluence with the East Inflow Canal, and some of the local area at both the east and west ends of the lake.

Despite these physical changes the concept and location of natural drainage areas still has important legal and practical implications in calculating entitlements under flow apportionment with the United States. For Cypress Lake sub basin the present Highway No. 21, near the east boundary of 24-6-26-W3, as shown on Figure 1, follows closely the natural drainage divide across the valley between Cypress Lake to the west and Frenchman River main channel to the east.

2. Divisions Along Frenchman River Main Stem

East of Cypress Lake the Frenchman River basin in Saskatchewan contains an estimated river length of 266 miles [1], and as previously mentioned, is relatively narrow in width. Since this long narrow basin is far from uniform along its length, it is advantageous to divide this basin into river reaches or basin segments for analysis purposes[2].

Starting from the upper end of the basin the first basin segment considered in the present study extends along the river from below Cypress Lake sub basin to Eastend. This is a major runoff producing area, located mainly in the south slopes of the Cypress Hills, which contributes directly to Frenchman River flow. Most of the area is drained by four main creeks whose tributary areas reach back to the summit of the hills. As previously mentioned, runoff from two of these creeks - Belanger and Davis - can be diverted into Cypress Lake. To the east of Davis Creek are the two remaining major creeks,

---

[1] See Table 6 of Environment Canada report: "Frenchman River Hydrology Study" by D. R. Cuthbert and E. R. Langley, Water Planning and Management Branch, March, 1974.

[2] For convenient reference in this report the term "basin segment" will refer to the local area that may contribute runoff to the river within the corresponding "river reach". For example Basin Segment No. 2 is the local area which may contribute to river flow along the length of River Reach No. 2. Similarly Basin Segment No. 3 is locally tributary to River Reach No. 3, and so on.

Fairwell and Conglomerate, and the combined area drained by these two creeks constitutes about 50 per cent of the total tributary flow to the Frenchman River in this segment. Examples of smaller creeks draining areas closer to the river are Moirvale Creek between Davis and Fairwell, and Blacktail Creek between Fairwell and Conglomerate Creeks.

Maximum relief in this area is approximately 389 m, (1275 feet), ranging from highs in the Cypress Hills of 1303 m (4275 feet) to a low at Eastend of 914 m (3000 feet).

Downstream from Eastend there is a considerable change in basin characteristics, with the drainage area running in a general southeastward direction, as shown on Figure 1. For study purposes the second segment extends along the river from Eastend to Highway No. 37. Compared to Segment No. 1 it is an area of low relief, and the relatively few tributary creeks drain areas to the south of the river rather than from the north.

Segment No. 3 extends downstream along the river from Highway No. 37 to a discontinued hydrometric station in SW 30-5-15, called Frenchman River at 50-Mile. Here basin width increases again with maximum relief significantly greater than in Segment No. 2. Numerous tributary creeks drain an area which is mainly to the north of the main river channel.

Downstream of the 50-Mile location the river changes direction from a generally east flowing to a southeast flowing stream. The downstream boundary of Segment No. 4 coincides with the location of former hydrometric station 11AC051, below Val Marie, in NE 9-3-13-W3. Much of the drainage area in this segment, and the best runoff yielding part of the area, lies to the east and north of the main river channel. Drainage is well developed with positive slopes, and there is a maximum relief of approximately 229 m (750 feet). Denniel Creek is the main tributary in this area, joining the river near Val Marie. It drains a large area which extends back to the summit of hills dividing the Frenchman and Wood River basins.

The fifth and final river segment considered in the study extends from the Frenchman River below Val Marie to the International Boundary. To some extent this is a continuation of Segment No. 4 with similar terrain, aspect and drainage development. However the maximum relief is greater by about 61 m (200 feet), slopes appear characteristically steeper, and the drainage pattern more intensively developed. Much of the area is drained by the three named tributaries: Breed, Little Breed and Otter Creeks, which drain off the hills to the northeast.

These five main basin segments, along with some natural divisions of a segment considered in the study, are outlined and identified in Table 2. There are also main tributary creeks, such as those already mentioned, which may be considered separately in the study, but which are part of the total area contributing to river flow along a given length of the main channel. The location of the Cypress Lake sub basin, the various basin segments and tributary creeks is shown on Figure 1.

Table 2
BASIN SEGMENTS AND DIVISIONS
ALONG FRENCHMAN RIVER MAIN CHANNEL

No. of Basin Segment	Division of Segment	Identification of Area Along Main River Channel	Hydrometric Station or Other Feature at Area Boundary	
			Upstream	Downstream
1		Below Cypress Lake sub basin to Eastend	Hwy. #21	11AC001
2		From Eastend to Highway #37	11AC001	11AC067
	2A	From Eastend to Hydr. Sta. 11AC057	11AC001	11AC057
	2B	From Hydr. Sta. 11AC057 to Highway #37	11AC057	11AC067
3		From Highway #37 to 50-Mile	11AC067	11AC023
4		50-Mile to below Val Marie	11AC023	11AC051
	4A	50-Mile to Val Marie Reservoir	11AC023	11AC062
	4B	Below Val Marie Res. to Hydr.Sta.11AC051	11AC062	11AC051
5		From Hydr. Sta. 11AC051 to International Bdry.	11AC051	11AC041
	5A	From Hydr. Sta. 11AC051 to below Breed Creek	11AC051	11AC027
	5B	From Sta. 11AC027 to International Bdry.	11AC027	11AC041

Chapter III

RUNOFF POTENTIAL AND WATER USE

A. DRAINAGE AREAS

Use was made of 1:50 000 national topographic maps and aerial photos to draw boundaries for the gross, wet and effective drainage areas tributary to each sub area or river reach throughout the basin. These initially located boundaries were then reviewed in conjunction with Water Rights staff, and compared in detail to corresponding boundaries used by them in recent years for the purpose of water administration. As a result of this two step process any apparent inconsistency in either set of drainage boundaries was eliminated, resulting in an agreed set of boundaries for use in both water administration and in the present study.

1. Cypress Lake Sub Basin

Contributing drainage areas at the location of former hydrometric stations on each of Oxarat and Sucker Creeks were outlined and planimetered on 1:50 000 topographic maps. The local drainage area tributary to the natural Cypress Lake was also evaluated and this included small areas, tributary to the above-mentioned creeks but downstream of the hydrometric stations, which, under natural conditions, would have drained into Cypress Lake.

It was estimated that construction of the two dams confining Cypress Lake, along with associated diversion works, reduced the local drainage area for the lake by 29.5 square kilometres (11.4 mi^2). This reduction consists of 21 square kilometres (8.4 mi^2) at the east end and 7.8 square kilometres (3.0 mi^2) at the west end of the present lake.

The estimated natural drainage areas tributary to Cypress Lake are listed below in Table 3.

Table 3

CYPRESS LAKE NATURAL DRAINAGE AREAS

Drainage Area Identification	Hydrometric Station No.	Effective Drainage Area		Gross (&Wet) Drainage Area	
		Sq. km	Sq. mi.	Sq. km	Sq. mi
Oxarat Creek in SE 29-6-27-3	11AC009	100.2	38.7	138.0	53.3
Sucker Creek in SW 25-6-26-3	11AC008	89.1	34.4	89.1	34.4
Cypress Lake Local Drainage Area	-	160.6	62.0	160.6	62.0
Totals	-	349.9	135.1	387.7	149.7

2. Frenchman River Main Stem

Natural drainage areas, as outlined on the 1:50 000 topographic maps, were measured for each of the main

creeks and for the local area tributary to the main river channel above Eastend. Downstream from Eastend drainage areas were evaluated for each basin segment or segment division as outlined in Table 2. Areas drained by major tributaries such as Denniel and Breed Creeks were treated separately, but as component areas within a given reach or basin segment.

In Table 4 the size of the effective, wet and gross drainage areas are summarized for each basin segment, main tributary creeks and local areas as considered in the study. The point on the stream to which a given area is tributary is denoted by the appropriate hydrometric station number, or by land location if no station has been operated there.

B. NATURAL RUNOFF VOLUMES

1. Natural Flow Computations

Natural flow computations in this study are on an annual basis, however, only flows during March 1 to October 31 period of each year are considered. In this respect the annual volumes calculated may be considered as conservative on the low side in years when spring freshets occur in the month of February, a fairly common occurrence in southwest Saskatchewan where chinook activity is prominent.

Table 4

NATURAL DRAINAGE AREAS FOR

BASIN SEGMENTS ALONG FRENCHMAN RIVER MAIN STEM

No. of Basin Segments	Identification of Area	Hydr. Sta. or Location (W3)	Drainage Areas					
			Effective		Wet		Gross	
			sq.km	sq.mi	sq.km	sq.mi	sq.km	sq.mi
1	Belanger Creek	11AC016	158.8	61.3	160.8	62.1	160.8	62.1
	Davis Creek	11AC004	116.3	44.9	116.3	44.9	116.3	44.9
	Fairwell Creek	11AC003	341.9	132.0	341.9	132	341.9	132
	Conglomerate Creek	NW 28-6-23	245.0	94.6	245.0	94.6	245.0	94.6
	Local Area Segment #1	11AC001	327.1	126.3	353.0	136.3	353.0	136.3
	Totals Basin Segment #1	11AC001	1189.1	459.1	1217	470	1217	470
2	Basin Segment 2A	11AC057	456.6	176.3	534.6	206.4	534.6	206.4
	Basin Segment 2B	11AC067	181.0	69.9	200.5	77.4	200.5	77.4
	Totals Basin Segment #2	11AC067	637.7	246.2	735	284	735	284
3	Basin Segment #3	11AC023	632.2	244.1	689	266	689	266
4	Basin Segment #4A	11AC062	305.9	118.1	323.5	124.9	395.0	152.5
	Denniel Creek #4B	11AC025	468.5	180.9	492.4	190.1	492.4	190.1
	Local Area in Segment 4B	11AC051	272.2	105.1	362.1	139.8	486.9	188.0
	Totals Basin Segment #4	11AC051	1046.6	404.1	1178	455	1375	531
5	Breed Creek	11AC026	248.4	95.9	297.6	114.9	297.6	114.9
	Local Area Segment #5A	11AC027	365.7	141.2	405.3	156.5	405.3	156.3
	Totals Basin Segment #5A	11AC027	614.1	237.1	702.9	271.4	702.9	271.4
	Little Breed Creek	11AC028	159.5	61.6	159.5	61.6	159.5	61.6
	Local Area Segment #5B[1/]	11AC041	171.7	66.3	171.7	66.3	171.7	66.3
	Totals Basin Segment #5B	11AC041	331.3	127.9	331.3	127.9	331.3	127.9
	Totals Basin Segment #5	11AC041	945.4	365.0	1034	399	1034	399
	Total Segments #1-5 incl.	11AC041	4451.0	1718.5	4853	1874	5050	1950

1/ Figures for Local Area Reach #5B include 17.6 square kilometres (6.8 mi^2) of effective drainage area in the United States, but tributary to the river immediately upstream of the hydrometric station 11AC041. This area is included within the drainage boundaries shown on the map in Figure 1.

A natual flow array was constructed for each point of interest, using recorded and estimated flows and water use information for the period 1911-81 inclusive.

2. Cypress Lake and Basin Segment No. 1

As previously noted there is a long period of record for the main channel hydrometric station 11AC001 at Eastend[1]/. For some of the years of missing record for that station during the 1909-1981 period, river flows were recorded at a nearby upstream hydrometric station 11AC018, Frenchman River above Eastend. There are also some overlapping years of record, which allows a comparison of flows at the two stream locations for a given year. Flows passing each of these stations would have been reduced by the quantity of upstream diversions. Upstream of station 11AC001 for example, storage losses occur in Eastend reservoir, which came into operation in 1939, and flow is diverted into Eastend Canal, for which records are available for years starting in 1937.

Flows occurring at Eastend are affected by other manmade changes in the area tributary to Basin Segment No. 1. There are many individual projects of varying size using water, some of which date back to the early years of the 1909-81 period. By 1939, as previously noted, a major

1/ Since construction of Eastend Reservoir and starting in 1939, the station has been called "Frenchman River below Eastend Reservoir."

diversion was in operation from upper Davis into Belanger, from the latter creek into Cypress Lake, and releases from storage in the lake could be made to the Frenchman River. Use was made of recorded data for these various diversions along with recorded flow at or above Eastend, to estimate natural flow at the station 11AC001 location for each year during the period 1911-81 inclusive. Allowance was made, assuming a 20 per cent return flow[1]/, for small project diversions in Basin Segment No. 1. For a relatively few years, such as 1911-13 and 1931-35 inclusive, records were incomplete for flow at both the stations 11AC001 and 11AC018. For these missing years back to and including 1912, use was made of natural flows estimated by PFRA in their 1976 Hydrology Report No. 84 (see footnote on page 12). For the missing year 1911 an estimate of flow at Eastend from an earlier study[2]/ done for the Prairie Provinces Water Board, was accepted for use in the present study.

1/ Assumptions for return flow in this study are 20 per cent for small projects and 25 per cent for major project diversions. These percentages are the same as those used by PFRA Hydrology in the 1976 study referred to, and used by Water Survey of Canada for the Frenchman River basin.

2/ "Compilation of Runoff Records for the Canadian Prairies" prepared by PFRA Hydrology Division for the Prairie Provinces Water Board: June, 1961: Revised April, 1967.

Fairwell Creek is one of the main tributary creeks in Segment No. 1. It drains a relatively large area which has runoff characteristics similar to those of adjacent creeks and to most of the area tributary to the river at Eastend. For the present study annual runoff for missing years of record on Fairwell Creek were estimated by means of a graphical correlation, in which runoff for years of recorded flow up to 1931 in Fairwell Creek were plotted against natural annual runoff for the corresponding years in the Frenchman River at station 11AC001. By this method a set of annual flows for Fairwell Creek in NW 30-6-24-W3 were obtained for the period 1911-81 inclusive, which on a year by year basis, were consistent in order of magnitude with natural flows of Frenchman River below Eastend reservoir.

Use was made of the limited hydrometric records for Davis, Belanger, Sucker and Oxarat Creeks, along with natural flows developed for Fairwell Creek, to estimate natural flows for each of these creeks and for the local natural drainage area tributary to Cypress Lake, for each year of the 71 year period 1911-81 inclusive. Methods used in these calculations included drainage area transfer and graphical correlation as seemed appropriate in each case. For years of recorded flow the volumes of known small project diversions, as supplied by Water Rights Branch, for a given year were included in

calculating the natural runoff volume. Runoff volumes for Oxarat and Sucker Creeks and the local drainage area were totalled for each year of the study period, to give a set also of natural annual inflows to Cypress Lake.

3. Basin Segments No. 2 and 3

Downstream from Eastend, as previously noted, there is a considerable change in the runoff characteristics of the local drainage area. Less runoff is expected proportionately from Basin Segment No. 2, between Eastend and Highway No. 37, and from Basin Segment No. 3, Highway No. 37 to 50-Mile, than from the upstream area in the Cypress Hills tributary to Segment No. 1.

With an almost complete absence of hydrometric records for local runoff in this part of the basin[1/], use was made of records for McDonald Creek near McCord. This is a relatively small drainage area within the Wood River basin, which, it was felt has considerable similarity in runoff characteristics to Basin Segments No. 2 and 3. Available records include flows during spring runoff in years 1965 through 1967, and during the entire season starting in 1969, to give a total record period of 16 years up to 1981.

1/ An unsuccessful attempt was made to use the relatively short period of record for Frenchman River below Eastend Irrigation Project to estimate local runoff. The increase in natural runoff at this location over that at Eastend should be due to local inflow. The results seemed inconsistent, and, with the short period of record available, did not provide a reliable basis for estimating local natural runoff.

Small project diversions in the area tributary to McDonald Creek near McCord, were tabulated from Water Rights Branch records. The total diversion volumes in a given year were then used, along with recorded flow, to estimate natural runoff in those years for which records are available. Annual runoff for missing years of record on McDonald Creek were estimated by means of a graphical correlation, in which natural runoff for years of recorded flow in that creek were plotted against natural runoff for the corresponding years in Wood River near Lafleche[1]/. By this method a set of annual flows for McDonald Creek near McCord was obtained for the entire period 1917-81 inclusive.

The estimated natural runoff volumes for McDonald Creek near McCord for the 1917-81 period were tabulated in order of magnitude, and a plotting position assigned to each value. Those values representing years of actual record were plotted on Gumbel probability paper, and a frequency curve drawn on the basis of the plotted points. Runoff volumes for this station were then used to estimate runoff in each of Basin Segments No. 2 and 3 downstream from Eastend, on the basis of the relative

---

1/ A set of Wood River near Lafleche natural runoff volumes for each of the years 1917-79 inclusive was used in the "Wood River near Gravelbourg Hydrology Study". For an outline of the source and basis of these flow values, see page 6 of Saskatchewan Environment Hydrology Report HYD-4-8, October, 1981.

magnitude of the effective, wet and gross drainage areas. These estimated runoff values were then used, as in the case of McDonald Creek, to draw frequency curves for the respective basin segments in Frenchman River basin.

4. Basin Segment No. 4

Basin Segment No. 4 drains into the Frenchman River between the 50-Mile location in SW 30-5-15-W3 and the hydrometric station 11AC051 near Val Marie. More than one-third of this area is drained by Denniel Creek at hydrometric station 11AC025, and the runoff characteristics of this area tributary to the creek are quite similar to, and representative of, those in the area as a whole. Since, despite gaps, there is a long total period of record available for flow in Denniel Creek, it was felt that these records are acceptable as a base from which to estimate runoff in Basin Segment No. 4.

For Denniel Creek, as indicated in Table 1, there are a total of 29 missing years of record since the hydrometric station was first established in 1914. There are additional years of partial record with no data available for the important spring and summer months. In order to estimate annual runoff for the missing years use was made of the consistent records since 1924, for nearby McEachern Creek at the International Boundary. However,

as was done in the case of McDonald Creek, the recorded annual flows of both basins were first changed to natural flows by allowing for the total of small diversions in the respective basin for each given year.

A graphical correlation based on the years of common record on Denniel and McEachern Creeks, was used to estimate natural runoff for the missing years of record on Denniel Creek. This same correlation was also used to estimate natural runoff in McEachern Creek for earlier years, extending the period of record for that creek back to 1914, the starting year for flow records on Denniel Creek.

In similar steps to those already outlined in the case of McDonald Creek near McCord, natural runoff values for years of actual record were plotted on Gumbel paper and a frequency curve drawn for each of Denniel Creek near Val Marie and McEachern Creek at the International Boundary. Runoff volumes for Denniel Creek near Val Marie were then used to estimate natural runoff in each year of the period, 1914-81 inclusive, for the remaining portion of Basin Segment No. 4 in the Frenchman River basin.

5. Basin Segment No. 5

Basin Segment No. 5 was considered in the study to be hydrologically similar to the adjoining basin to the

east, McEachern Creek at the International Boundary. In addition to proximity, some of the hydrological characteristics considered for this similarity were: general aspect, slope, maximum relief and intensity of natural drainage development.

The frequency curve previously developed for McEachern Creek was used to estimate runoff for each year in the period 1914-81 for a given tributary creek or subdivision of Basin Segment No. 5, on the basis of the relative size of the effective, wet and gross drainage areas. On this basis median local runoff was estimated for Breed, Little Breed and Otter Creeks, as well as for the local drainage area along the river above and below the Breed Creek confluence.

Early in the present study natural runoff volumes for Frenchman River at the International Boundary were estimated for each year in the 70 year period 1911-80 inclusive. For these calculations use was made of natural flow figures computed for the IJC and figures for earlier years estimated by PFRA in their 1976 study. From the frequency curve drawn the estimated median natural runoff at the International Boundary is 77 500 dam^3 (63,000 acre-feet).

C. WATER DIVERSION AND USE

The tabulation prepared by Water Rights Branch, of historical and present small project diversion in the basin was used in the study as required, and as outlined above in specific instances, to convert recorded into estimated natural flows. Another use of the tabulation was to evaluate present water use in each basin segment, or portion thereof, considered in the study.

In the evaluation of present use some significance was attached to the question of whether or not a certain project diversion is located within the effective or contributary drainage area[1/] of a given basin segment or division. If so then the water diverted is water that would, under natural conditions, contribute to streamflow in a median runoff year, and as such is shareable, after allowing for conveyance to the International Boundary, on a 50 per cent basis with United States. On the other hand if the project diversion is outside the effective drainage area, the water diverted would not contribute to streamflow in a median or low runoff year, and therefore in such years is not shareable with the United States. In a higher than median runoff year no difficulty would be expected in meeting the international commitment.

1/ For convenient reference in this report and also as used in water administration, the term "contributary area" refers to the area which would contribute to streamflow in a median runoff year, actually the effective drainage area. Conversely the "non-contributary area" refers to that area outside the effective drainage area which does not contribute to streamflow in a median runoff year.

There are three major or group irrigation projects in the basin, which, as previously mentioned, are supplied from storage in the respective Eastend, West Val Marie and Val Marie reservoirs. In all three cases the original water right application by PFRA for a reservoir stated that the purpose of the project was for irrigation. In the application the area intended for irrigation was referred to as a general block in the case of Eastend, and listed by land location for each of the other two projects. While diversions on these projects date back to at least 1939, there seems to be, up to the present, a deficiency of information concerning items such as quantity of water diverted, areas irrigated, depth of application, number of irrigations per year and general operational practise or procedure. This lack of information has been due, at least in part, to the fact that an up to date, detailed, as-constructed plan for each project has never been filed with the Water Rights Branch.

In the course of the present study several enquiries and requests for information were directed to PFRA Regional Office in Swift Current with positive results. Received to date is one copy of a general plan for each of the three irrigation projects, and a preliminary tabulation of elevations and capacities for each reservoir. Copies of available irrigation records for past years were also received, which mainly indicated areas irrigated with one or two irrigations on each

project. Included in these records is an irrigation summary for each year in the 1969-81 period for each of the three major projects. Some fairly general information was received verbally in response to specific questions. For example a gross application rate of .55 dam^3 per hectare (1.1 acre-feet per acre) for each irrigation is considered as an approximate or fairly general figure, but which may vary somewhat from one project to another. Return flows of 25 per cent for major irrigation diversions were assumed, as previously mentioned.

Apart from irrigation applications, any water stored in a reservoir during a period depletes the natural flow and increases the amount of water lost to evaporation. Storage loss at each reservoir will vary from year to year, depending on variable factors such as project operation and net evaporation. However for water administration purposes a general figure for reservoir loss, if applicable, is included as part of the volume of water allocated to that particular project. Reservoir losses allocated to the three main stem reservoirs are: Eastend 506 dam^3 (410 acre-feet), West Val Marie 728 dam^3 (590 acre-feet), and Val Marie 1727 dam^3 (1400 acre-feet). As the largest reservoir, Val Marie also has the largest storage capacity relative to the local area to be irrigated, and in addition will receive some return flow from the West Val Marie irrigation project a short distance upstream. Val Marie reservoir could therefore, be operated at a relatively high level during the irrigation season.

In Eastend irrigation project there are about 1162 hectares (2871 acres) irrigated, according to figures received for 1982. At an 45.7 centimetre (18 inch) duty this would require a net withdrawal from storage or river flow of 5312 dam^3 (4306 acre-feet). According to the 1969-81 irrigation summary previously mentioned, water was applied in Eastend project to an average of 1057.5 hectares (2613 acres) each year, and the average yearly total for two irrigations was 1892.8 hectares (4677 acres). If a gross diversion rate of .55 dam^3 per hectare (1.1 acre-feet per acre) and a 25 per cent rate of return flow is applied, the irrigation summary would indicate an average annual gross diversion of 6346 dam^3 (5145 acre-feet) and a corresponding net diversion of 4760 dam^3 (3859 acre-feet) for the project over this recent 13 year period. With only 3362 dam^3 (2723 acre-feet) of live storage available at Eastend Reservoir, the gross diversion can only be met through diversions from upstream sources into the reservoir in between and during irrigation applications.

West Val Marie irrigation project has an irrigated area listed at 1106.4 hectares (2734 acres), which, with a standard 45.7 centimetre (18 inch) duty, would require 5063 dam^3 (4101 acre-feet) of net diversion. In practice in the 13 year period 1969-81 inclusive, the area irrigated each year was consistently less, averaging 989.1 hectares (2444 acres), but with an average total covered in two irrigations of 1948.6 hectares (4815 acres). Using the same rates for gross

diversion and return flow as for Eastend project, irrigation of this total area would require 6533 dam^3 (5296 acre-feet) of gross and 4900 dam^3 (3972 acre-feet) of net diversion. West Val Marie reservoir has a live storage capacity of only 1252 dam^3 (1014 acre-feet) and therefore requires diversion from upstream sources during the summer season in order to meet total project requirements.

The irrigated area in Val Marie irrigation project is listed at 1741 hectares (4302 acres), which, at an 45.7 centimetre (18 inch) duty, would require a net diversion of 7960 dam^3 (6453 acre-feet). From the tabulated summary the average area irrigated during the 13 year period 1969-81 inclusive was 1573 hectares (3887 acres), but with an average total area covered in two irrigations[1]/ of 3019.4 hectares (7461 acres). Using the same factors as for the other two projects, irrigation of this total area would require 10123 dam^3 (8207 acre-feet) of gross and 7592 dam (6155 acre-feet) of net diversion from storage or river flow.

In Table 5(a) the various basin segments and subidivisions considered in the study are listed, along with the corresponding estimate of median natural runoff, small project diversions and major project use for each area. The median

---

1/ In the case of both Val Marie and West Val Marie projects the total area covered in two irrigations in 1981 was omitted from the tabulation. Therefore the average figure quoted for each of these projects is for a 12 year period only, that is, 1969-80 inclusive.

Table 5(a)

ANNUAL MEAN NATURAL RUNOFF AND PRESENT DIVERSION

FOR FRENCHMAN RIVER BASIN AREAS

(METRIC UNITS)

Basin Segment	Segment Description along Frenchman River, Area Name, or Tributary Location (W3)	Median Natural Runoff (dam^3)	Present Water Diversion or Use (dam^3)			
			Small Project Diversions			Major Projects Reservoir Loss ~75% of Diversion
			Contributary Area[1]		Non-Contributary Area (100%)	
			Gross (100%)	Net (80%)		
	Oxarat Creek in SE 29-6-27	1790	1582	1266	301	
	Sucker Creek in SW 25-6-26	3270	548	438	0	
	Cypress Lake Local Drainage Area	2860	94	75	0	
	Total Cypress Lake Natural Basin	7920	2224[1]	1779[1]	301	
1	Belanger Creek in SW 30-6-25	5920	1406	1125	31	
1	Davis Creek in NE 29-6-25	4930	113	90	0	
1	Fairwell Creek in NW 30-6-24	12340	1979	1583	0	
1	Conglomerate Creek above Frenchman River	8630	608	486	0	
1	Local Drainage Area in Reach #1	10120	1295	1036	123	
1	Total Frenchman River to Eastend	41940	5401	4321	154	(Eastend)5267
2A	Eastend to Hydrometric Station 11AC057	5800	1229	983	142	
2B	Hydrometric Station 11AC057 to Highway #37	2340	296	237	0	
2	Frenchman River, Eastend to Highway #37	8140	1525	1220	142	
3	Total Frenchman River, Highway #37 to 50-Mile	8080	905	724	0	
4A	Frenchman River, 50-Mile to Val Marie Res.	3270	249	199	0	West Val Marie
4B	Denniel Creek in SW 21-4-13	4930	634	507	37 4A	5627
4B	Local: Val Marie Reservoir to below Val Marie	2900	545	436	517	Val Marie 9319
4	Frenchman River, 50-Mile to below Val Marie	11100	1428	1142	554	Total 14046
5A	Local Area to below Breed Creek Confluence	6240	512	410	113	
5A	Breed Creek in SE 15-2-11	4240	118	94	95	
5A	Total Segment Area #5A	10480	630	504	208	
5B	Local Area below Breed Creek to Inter. Bdry.	2160	343	274	0	
5B	Little Breed Creek in SW 11-2-11	2680	90	72	0	
5B	Otter Creek above Confluence	710	14	11	0	
5B	Total Segment Area 5B	5550	447	358	0	
5	Total Segment #5	16030	1077	862	208	
1-5	Totals: Segments #1 to 5 inclusive	85290	10336	8269	1782	20213[2]

1/ Figures given in these columns are for the contributary area within the given local subdivision. As one example the "contributary area" for Cypress Lake natural basin would not be part of the "contributary area" for Frenchman River main stem.

2/ This figure does not take into account the net loss to the basin from Belanger and Davis Creek diversions to Cypress Lake, that are lost to the Frenchman River through evaporation on Cypress Lake and diversion to Battle Creek basin. This amount is difficult to estimate due to lack of adequate hydrometric information.

Table 5(b)

ANNUAL MEAN NATURAL RUNOFF AND PRESENT DIVERSION

FOR FRENCHMAN RIVER BASIN AREAS

(ENGLISH UNITS)

Basin Segment	Segment Description along Frenchman River, Area Name, or Tributary Location (W3)	Median Natural Runoff (ac-ft)	Present Water Diversion or Use (ac.-ft.)			
			Small Project Diversions			Major Projects Reservoir Loss -75% of Diversion
			Contributary Area[1]		Non-Contributary Area (100%)	
			Gross (100%)	Net (80%)		
	Oxarat Creek in SE 29-6-27	1450	1283	1026	244	
	Sucker Creek in SW 25-6-26	2650	444	355	0	
	Cypress Lake Local Drainage Area	2320	76	61	0	
	Total Cypress Lake Natural Basin	6420	1803[1]	1442[1]	244	0
1	Belanger Creek in SW 30-6-25	4800	1140	912	25	
1	Davis Creek in NE 29-6-25	4000	92	74	0	
1	Fairwell Creek in NW 30-6-24	10000	1604	1283	0	
1	Conglomerate Creek above Frenchman River	7000	493	394	0	
1	Local Drainage Area in Reach #1	8200	1050	840	100	
1	Total Frenchman River to Eastend	34000	4379	3503	125	(Eastend) 4270
2A	Eastend to Hydrometric Station 11AC057	4700	996	797		
2B	Hydrometric Station 11AC057 to Highway #37	1900	240	192		
2	Total Frenchman River, Eastend to Highway #37	6600	1236	989	0	0
3	Frenchman River, Highway #37 to 50-Mile	6550	734	587	0	0
4A	Frenchman River, 50-Mile to Val Marie Res.	2650	202	162	0	West Val Marie
4B	Denniel Creek in SW 21-4-13	4000	514	411	30 4A	4562
4B	Local: Val Marie Reservoir to below Val Marie	2350	442	354	419	Val Marie 7555
4	Frenchman River, 50-Mile to below Val Marie	9000	1158	926	449	Total 12117
5A	Local Area to below Breed Creek Confluence	5060	415	332	92	
5A	Breed Creek in SE 15-2-11	3440	96	77	77	
5A	Total Segment Area #5A	8500	511	409	169	0
5B	Local Area below Breed Creek to Inter. Bdry.	1750	278	222	0	
5B	Little Breed Creek in SW 11-2-11	2170	73	58	0	
5B	Otter Creek above Confluence	580	11	9	0	
5B	Total Segment Area 5B	4500	362	290	0	0
5	Total Segment #5	13000	873	699	169	0
1-5	Totals: Segments #1 to 5 inclusive	69150	8380	6704	1445	16387[2]

[1] Figures given in these columns are for the contributary area within the given local subdivision. As one example the "contributary area" for Cypress Lake natural basin would not be part of the "contributary area" for Frenchman River main stem.

[2] This figure does not take into account the net loss to the basin from Belanger and Davis Creek diversions to Cypress Lake, that are lost to the Frenchman River through evaporation on Cypress Lake and diversion to Battle Creek basin. This amount is difficult to estimate due to lack of adequate hydrometric information.

runoff total of 85290 dam^3 (69150 acre-feet), as shown, is a total of runoff originating in the five segments, as calculated separately for each basin segment and then summed for the entire basin, and it is not intended as an estimate of natural flow at the International Boundary; no channel and evaporation losses considered. It does not, therefore, necessarily conflict in any way with the estimate of 77500 dam^3 (63000 acre-feet) estimated in the 1973 study, for median natural runoff at the boundary; the difference in approach is sufficient to cause this magnitude of discrepancy. Of this median flow 50 per cent must be passed to the United states, and so is not available for allocation in Saskatchewan.

Median runoff into Cypress Lake natural basin, as previously mentioned, is not considered shareable under international apportionment, and therefore 100 per cent of this runoff is available for Canadian use. From the figures shown there is sufficient runoff in this sub basin to support further development, although Oxarat Creek has a relatively high allocation in the contributary area, with 71 per cent of the median flow presently used.

Despite the limitation on Canadian use from the main river flow, the figures in Table 5 tend to show on a segment by segment basis, but particularly in the downstream end of the basin, that there is water available for further project development.

For Segment No. 1 median runoff is shown at 41940 dam^3 (34000 acre-feet) as compared to net diversions for small water development in the contributary area of 5401 dam^3 (3503 acre-feet), and 5267 dam^3 (4270 acre-feet) for the major Eastend project. If 50 per cent of the median runoff or 20940 dam^3 (17000 acre-feet) is considered available for Canadian use, over 11385 dam^3 (9200 acre-feet) would be surplus to present minor and major diversions in Segment No. 1, and therefore available for other use downstream. On the other hand this apparent surplus from Segment No. 1 may not be a surplus from the viewpoint of the basin as a whole. Basin Segment No. 1 is a major runoff producing area for the basin, and there are two other major projects, West Val Marie and Val Marie, which are located downstream and which require more than local runoff for their water supply.

Figures shown in Table 5(a) indicate that in every one of the five Segments even the 50 per cent share of median annual runoff is large in comparison to the total volume used locally at present in small water development. This is particularly evident for Segment No. 5 with a total net diversion in the contributary area of 862 dam^3 (699 acre-feet) compared to a total median runoff in the area of 16030 dam^3 (13000 acre-feet). In this case only about 11 per cent of the local runoff, potentially available for use in Canada, is being utilized.

West Val Marie and Val Marie are major projects located in Basin Segment No. 4, and have a total net diversion as indicated in Table 5(a) of 14946 dam^3 (12117 acre-feet). Local runoff in this reach seems more than adequate to supply the present small water projects in this reach, but would be quite inadequate to supply the two major project diversions, especially since most of the local runoff, including all of that from Denniel Creek, will reach the river downstream fromboth reservoirs. As already outlined a surplus of median runoff from Segment No. 1 was estimated in excess of 11385 dam^3 (9200 acre-feet). Similar calculations for Segments No. 2 and 3, indicate a total surplus from the three segments above present use of over 18150 dam^3 (14700 acre-feet). Even after allowing for some channel losses, this volume, along with local runoff in Basin Segment No. 4 upstream of the respective reservoirs, should be an adequate supply for the two major projects, and still leave room for some further small water development in the basin upstream of these reservoirs.

Chapter IV

RESULTS OF THE STUDY

In the present study, the availability of water for various parts of the basin was evaluated. To this end drainage area boundaries were defined, records of historic and present water use were analyzed and reviewed, and natural flows were developed for each local area.

From carrying out this study and on the basis of the results, certain conclusions and recommendations can be drawn.

A. CONCLUSIONS

1. Hydrometric Records

There is a deficiency in hydrometric coverage for the purpose of water administration and of monitoring runoff in different areas of the basin. The present hydrometric network seems to be designed mainly to measure flows at key locations for the purpose of apportionment, rather than for basin area coverage and water administration. Attempts have been made in the past, especially in the 1908-14 period, to establish more complete coverage, but most of these stations were discontinued after a very few years, and have never since been reactivated.

For the important upstream area of the basin there are long-term records of flow at Eastend, which are certainly useful for water allocation as well as for apportionment, but there is a complete lack, since at least the 1930s, of any monitoring of tributary flow in both the Cypress Lake sub basin and in Basin Segment No. 1.

Similarly in the entire basin downstream from Eastend, tributary flow is monitored directly at only one hydrometric station, Denniel Creek near Val Marie. Records of stations along the main channel, which could be used indirectly for monitoring tributary flow are mostly fragmented and of very short duration. At present the only active station in the main river channel extending below Eastend almost to the International Boundary, is Frenchman River below Val Marie reservoir. This station is well located for measuring flows released or passed down the main channel immediately below the reservoir, but the records give little or no indication of local or tributary inflow from the adjacent upstream area. Even if this station has some potential for the latter purpose, a second suitably located main channel station would be required in order to monitor the incremental inflow originating from the local area between the two stations.

2. Water Supply and Present Use

In Cypress Lake sub basin and in each of the five basin segments considered in the study, the available share of median natural runoff[1/] exceeds the present requirements for small water use projects in the respective contributary area, by a wide margin. Basin Segment No. 5, at the downstream end of the basin, has the lowest relative development, with only 11 per cent of the available median runoff being utilized. At the other end of the basin and at the other extreme, Oxarat Creek seems to have a relatively high use factor for the contributing area, with a net diversion amounting to 71 per cent of its median natural runoff. In this respect Oxarat Creek is not typical of other basin areas, or even of Cypress Lake sub basin as a whole.

Runoff from Basin Segment No. 1, in addition to supplying Eastend project, must, in considerable part, meet the requirements of the two major irrigation projects above Val Marie. These three major projects are all downstream from Basin Segment No. 1, and the latter is a major runoff producing area for at least the upper half of the basin. It was found in the study that median natural

---

1/ The "available share" would be 100 per cent in the case of Cypress Lake sub basin, and 50 per cent of median runoff for the remainder of the basin.

runoff is considerably in excess of the combined present requirement for minor diversions in the area, and the major diversion for Eastend irrigation project. On a median runoff year this surplus of available water, plus corresponding smaller quantities, from local areas downstream of Eastend, would be sufficient to meet the present needs of West Val Marie and Val Marie projects, and still allow some further small water development in each of the local areas upstream.

B. RECOMMENDATIONS

1. Hydrometric Program

A major hydrometric program for the basin should be undertaken at the earliest possible time, primarily for the purpose of monitoring tributary flow in various local areas. At the same time there are no presently active stations in the basin which should be abandoned, since there are none which are in excess of present and future needs.

In the initial period of the hydrometric program stations should be established or reactivated in all major creeks draining into Cypress Lake natural basin and Basin Segment No. 1. After a period of years some of these stations could be discontinued, but several should be selected for continued operation as key long-term stations.

To provide more accurate and reasonably detailed monitoring of runoff for the basin downstream of Eastend, an intensification of hydrometric coverage in this area is required. Some former hydrometric stations are well located for this purpose. Along the main river channel former stations 11AC057, 11AC067, 11AC023, 11AC051 and 11AC027, all identified in Table 1, should be reactivated and operated concurrently for a substantial period of years. Direct monitoring of tributary creek flow should include a station on either Breed Creek or Little Breed Creek in Basin Segment No. 5, and probably one on a representative creek in Basin Segment No. 3, such as the former station on Bate Creek, 11AC024. The presently active station 11AC025, on Denniel Creek, should continue in operation as a long-term station for tributary creek flow in this general area.

2. Further Study

In the present study for various parts of the basin, natural runoff has been estimated and project diversion analyzed, on the basis of an annual time period. In contrast the treaty governing apportionment could be interpreted as requiring division of flow on a daily basis, but, for practical considerations and by agreement, it is calculated for ten day periods through the season March 1 to October 31.

To make natural flow and project use figures from the present study more meaningful in terms of water administration and division of flow, it would be of advantage to subdivide each annual value into its monthly components. Using a computer model for flow routing in the basin, monthly runoff and diversion quantities could be used to test in more detail, the effect of present or proposed development, in relation to the available water supply, in each local area and for the basin as a whole. In this dynamic model it should be possible to include allowance for such relevant factors as channel loss, effect of storage, time of travel and project operation, which would allow a more detailed analysis to be made.

MAPLE CREEK
HARRIS
PROV FOREST
HILLS
MERRYFLAT
1
2
13
11AC003
11AC009
11AC053
11AC064
11AC072
11AB076
11AB077

13
SHAUNAVON
ACDO
EAST END
EAST END RESERVOIR
ACDO
FRENCHMAN
2
2B
37
3
IIACO67
2A
IIACO67
CLIMAX

SHAUNAVON

BRACKEN

CLIMAX

GLEN McPHERSON

MANKOTA

ST. MARIE

WHITEWATER

RIVER

TP 5

TP 4

TP 3

TP 2

TP 1

4

4A

4B

5

5A

5B

2B

3

11AC024

11AC023

11AC065

11AC064

11AC025

11AC067

11AC028

11AC027

11AC026

11AC047

WATE

BASI

BOU
SEG

2 - NUM

BOU
ARE

2A - NUM
SEG

11AC001 - ACT

11AC023 - INA

ARE
EFF

ARE
WE

37 - H.

Miles 5

Kilometres 5

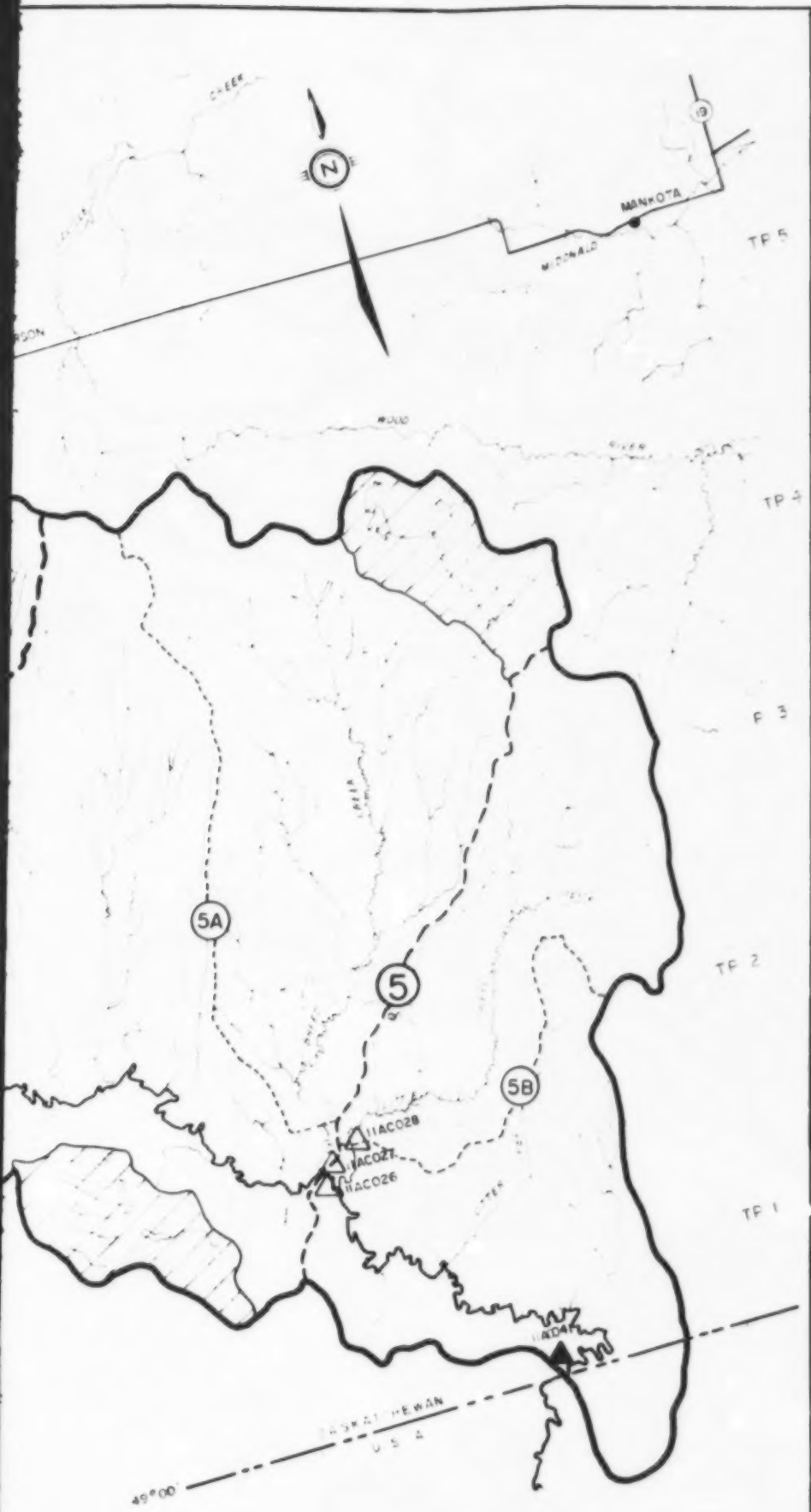
Saskat
Hy

FRENC

DRAINAGE
AND HY

Drn J.W.W

Ck'd



LEGEND

- WATERSHED BOUNDARY
- BASIN SEGMENT BOUNDARY
- BOUNDARY OF SUB-BASIN WITHIN SEGMENT
- (2) – NUMBER FOR BASIN SEGMENT
- BOUNDARY OF LOCAL TRIBUTARY AREA
- (2A) – NUMBER FOR DIVISION OF BASIN SEGMENT
- 11AC001 ▲ – ACTIVE HYDROMETRIC STATION
- 11AC023 △ – INACTIVE HYDROMETRIC STATION
- – AREA EXCLUDED FROM EFFECTIVE DRAINAGE AREA
- – AREA EXCLUDED FROM EFFECTIVE DRAINAGE AREA
- (37) – HIGHWAY

Saskatchewan Environment
Hydrology Branch

FRENCHMAN RIVER BASIN
SHOWING
DRAINAGE BOUNDARIES, DIVISIONS
AND HYDROMETRIC STATIONS

Drn	I W W	Date	APRIL 4/81
Ck'd		Plan No.	H2-2-5(8)

Figure 1

POOR

QUALITY

ORIGINAL